[Name of Document] Application for Patent
[Reference No.] 0306963
[Date of Filing] October 30, 2003
[Addressee] Commissioner of Japan Patent Office
[Int'l Class] G11B 7/00
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[Priority Document]

[Application No.] 2003-10391

[Date of Filing] January 17, 2003

[Application Fee]

[Prepayment No.] 007777

[Amount of Payment] 21,000 Yen

[List of Attached Documents]

[Name of Document] Scope of Claims 1

[Name of Document] Specification 1

[Name of Document] Drawings 1

[Name of Document] Abstract 1

[General power of Attorney No.] 0010869

[Name of Document] Scope of Claims

[Claim 1]

An initialization method characterized by comprising:

initializing a phase change optical recording medium with a laser beam with a power density of from 15 to 22 $mW/\mu m^2$ at a linear velocity of from 8 to 12 m/s to initialize the phase change optical recording medium, wherein the phase change optical recording medium comprises:

a transparent substrate having a guide groove on the surface thereof;

a first protective layer which is overlaid on the transparent substrate;

a recording layer which is overlaid on the first protective layer and which essentially consists of a material which is represented by the following composition formula: $Ag_{\alpha}X_{\beta}Sb_{\delta}Te_{\varepsilon}Ge_{\gamma}$, wherein X is at least one element selected from the group of Ga, In, Tl, Pb, Sn, Bi, Cd, Hg, Mn, Dy, Cu and Au, and α, β, δ, ε, and γ have units of atomic % and satisfy the following relationships:

$$\alpha + \beta + \delta + \varepsilon + \gamma = 100;$$
$$0 \leq \alpha \leq 2;$$
$$0 \leq \beta \leq 10;$$
$$60 \leq \delta \leq 80;$$
$$0 \leq \varepsilon \leq 30;$$
$$1 \leq \gamma \leq 10; \text{ and}$$

$5 \leq \alpha + \beta + \gamma \leq 9$ when at least one of α and β is greater than 0.

[Claim 2]

The initialization method according to Claim 1, characterized in that the recording layer has a thickness of from 8 to 20 nm.

[Claim 3]

The initialization method according to Claim 1 or 2, characterized in that the phase change optical recording medium further comprises an oxide layer which comprises at least ZrO_2 and which is located in at least one of a position between the recording layer and the first protective layer and a position between the

recording layer and the second protective layer.

[Claim 4]

The initialization method according to Claim 3, characterized in that the oxide layer comprises ZrO_2 as main component.

[Claim 5]

The initialization method according to Claim 3 or 4, characterized in that the oxide layer comprises a titanium oxide.

[Claim 6]

The initialization method according to Claim 5, characterized in that the content of the titanium oxide is not greater than 60 mole % based on a total amount of materials included in the oxide layer.

[Claim 7]

The initialization method according to any one of Claims 3 to 6, characterized in that the oxide layer further comprises at least one of a rare earth oxide and an oxide of a group IIa element exclusive of Be.

[Claim 8]

The initialization method according to Claim 7, characterized in that a content of said at least one of the rare earth oxide and the oxide of a group IIa element exclusive of Be ranges from 1 to 10 mole % based on ZrO_2.

[Claim 9]

The initialization method according to any of Claims 3 to 8, characterized in that the oxide layer has a thickness of from 1 to 20 nm.

[Claim 10]

The initialization method according to any one of Claims 1 to 9, characterized in that the irradiation is performed while the laser beam forms a spot having an area not greater than 200 μm^2 on a surface of the recording layer, and that a light source of the irradiation laser beam has an output power of from 0.7 to 2.5 W.

[Claim 11]

The initialization method according to any one of Claims 1 to

10, characterized in that the linear velocity is in a range within + or - 2 m/s of a crystallization limit speed of the recording layer.

[Claim 12]

The initialization method according to any one of Claims 1 to 11, characterized in that the irradiation is performed while the laser beam forms an oval-shaped spot, wherein the following relationship is satisfied: $d/n \leq pf \leq d(n-1)/n$,

wherein pf represents a transfer pitch of the laser beam, d represents a half width diameter of the oval-shaped spot in a longitudinal direction, and n is equal to or less than 5, and wherein there is no portion in the recording layer which is subject to irradiation multiple times.

[Name of Document] Specification

[Title of the Invention]

METHOD OF INITIALIZING PHASE CHANGE OPTICAL RECORDING MEDIUM

[Technical Filed of the Invention]

[0001]

The present invention relates to an optimal initialization method for a phase change optical recording medium in which information can be recorded in a wide range of linear velocity of from 3.5 to 14 m/s.

[Background Art]

[0002]

With an increase of the amount of information, a need exists for recording media in which a great quantity of information can be recorded and played back in high density and at high speed. Phase change optical recording media in which information is recorded and played back by irradiation with a laser beam, especially phase change optical discs, have excellent signal qualities and signals can be recorded therein in high density. In addition, such recording media have excellent high speed accessibility because one-beam overwriting can be easily performed thereon.

Such a phase change optical disc typically contains a light transparent substrate which has a guiding concave groove on a surface thereof for guiding a laser beam. On the light transparent substrate, at least a first protective layer, a phase change recording layer which reversibly changes its phase between an amorphous phase and a crystalline state upon irradiation by a light beam, a second protective layer and a metal reflective layer are overlaid in this order, and further a resin protective layer is provided on the metal reflective layer.

There is another type of disc in which two discs are bonded with a bonding layer therebetween. The disc is typically formed by using one or two optical discs having such a structure as described above with a bonding layer therebetween.

In order to play back data recorded in an optical disc, difference in reflectivity of the recording layer or difference in phase contrast of the reflected light is typically utilized. These differences are caused by the reversible phase change phenomena between an amorphous phase and a crystalline phase. The crystalline state is typically defined as a non-recorded and erasure state.

[0003]

The layers of the phase change optical disc described above are typically formed by a vacuum processing method such as sputtering methods and vapor evaporation methods. The state that a recording layer achieves immediately after the recording layer is formed in the manner mentioned above, which is called as-depo state, is an amorphous state in most cases. Therefore, it is necessary to crystallize the recording layer, which is called "initialization". The reason for performing this process is that the time required for crystallizing the as-depo amorphous state is extremely long compared with the time required for crystallizing an amorphous state (marks) that the recording layer achieves due to overwrite recording. The reason therefor is considered to be that there are few crystal nuclei in a recording layer in the as-depo state.

The recording principle in a phase change optical disc is described below.

To switch the state of a recording layer from an amorphous state to a crystalline state or vice-versa, a focused laser beam which is pulsed at the following three power levels is used;

(1) the highest power level of the three for fusing a recording layer;

(2) the medium power level of the three for heating a recording layer to a temperature which is just below the melting point of the material used in the recording layer and above the crystallization point thereof; and

(3) the lowest power level of the three for controlling heating and cooling of a recording layer.

Recording marks are formed by fusing a recording layer using a highest power level laser pulse followed by rapid cooling down. Therefore the recording layer achieves an amorphous state or fine crystal state and as a result the reflectivity of the recording layer lowers.

Recording marks are erased by using a medium power level laser pulse and the recording layer achieves a crystalline state.

By switching the power level of a laser pulse for writing, a crystalline state portion and an amorphous state portion are alternately formed in a recording layer, resulting in recording of information therein.

[0004]

Generally, the actual recording characteristics of an optical disc which is manufactured by the manufacturing process mentioned above and in which data are recorded in the recording method mentioned above, are greatly dependent on the characteristics of the materials used in the recording layer.

Specific examples of such characteristics of the materials for use in a recording layer are composition ratio, melting point, crystallization temperature and optical constants. Other than these

characteristics, the inventors of the present invention have defined "crystallization limit speed" by experiments.

"Crystallization limit speed" will be explained as follows.

When an optical disc in rotation is irradiated with DC light having a constant power while changing the linear velocity of the irradiation light beam (i.e., optical disc rotation speed), the recording layer is crystallized. When the disc rotation speed is low, the recording layer is gradually cooled down and thereby achieves a crystalline state again. When the disc rotation speed is high, the recording layer is rapidly cooled down and thereby achieves an amorphous state, namely the reflectivity lowers.

In this evaluation method, "the DC light having a constant power" is regarded as the laser pulse having the medium power level (erasure pulse) mentioned above. However, the actual power level of the DC light used is between the highest power level (recording pulse) and the medium power level (erasure pulse). This evaluation method focuses on the maximum linear velocity for crystallizing (erasure) the recording layer.

An example of reflectivity of the optical disc is illustrated in Fig.1. As illustrated in Fig.1, a speed at which the reflectivity begins to drop sharply is defined as the "crystallization limit speed".

Referring to Fig.1, when the linear velocity surpasses the crystallization limit speed (which is indicated by the bold straight line in Fig.1) of the recording layer, the reflectivity falls. This means that the crystallization (erasure) is not satisfactory in this region.

Therefore, it has been considered to be preferable that the linear velocity of an irradiation light beam for initialization or overwriting (i.e., erasure pulses) be sufficiently slow relative to the crystallization limit speed of a recording layer in order to obtain a good erasure ratio.

[0005]

The phase change optical recording medium targeted by the

present invention in which information can be recorded over a wide range of linear velocity of from 3.5 m/s to 14 m/s has to have good recording characteristics not only at a low linear velocity but also at a high linear velocity.

Therefore, the crystallization limit speed for a recording layer needs to be set to be around 10 m/s, which is approximately 4 m/s slower than the linear velocity (14 m/s) at high linear velocity recording.

When the characteristics of the recording layer are evaluated after the recording layer is initialized at a linear velocity which is sufficiently slow relative to the crystallization limit speed, and overwritten at a recording linear velocity of 14 m/s, the erasure ratio for initial repetitive recordings (i.e., when the number of overwriting is from one to around ten times) is low. This causes a problem in that overwriting should be performed multiple times after initialization to obtain a stable erase ratio.

The reason why the erase ratio is so low for the initial repetitive recordings is unclear. However, judging from the facts mentioned above, it is probable that the first crystalline state of the recording layer which is achieved after initialization is different from the second crystalline state which is achieved again when an amorphous mark is overwritten and erased.

Therefore the reflectivity in the recording layer of the second crystalline state for the initial repetitive recordings is non-uniform, resulting in increase of jitters.

In contrast, the reason why the erase ratio is stabilized after a recording layer is overwritten around 10 times is considered to be that the crystalline state achieved after the recording layer is overwritten 10 times is achieved after overwriting and erasing the recording layer in the initial crystalline state and therefore the reflectivity of the recording layer becomes uniform.

Therefore, to improve recording characteristics of initial repetitive recordings, how to make the reflectivity of the initial

crystalline state equal to that of the crystalline state achieved after overwriting (i.e., reflectivity of the crystal formed after overwriting and erasing marks initially recorded) has been an issue.

[0006]

The following published unexamined Japanese Patent Applications have disclosed phase change optical recording media which can restrain the increase of jitters which occurs in the first several overwritings, and initialization methods for the media.

However, there is no description about specific initialization conditions and methods such as power density and linear velocity in the first eight applications. The last six applications have mentioned initialization methods but the initialization conditions mentioned therein are different from those in the present invention or too wide. Therefore, these initialization conditions are not suitable for the target phase change optical recording medium of the present invention in which information is recorded and played back upon application of a laser beam at a linear velocity in a range of from 3.5 to 14 m/s.

[0007]

Patent document 1: a phase change optical recording medium in which a ratio Z is from 0.37 to 0.46, wherein Z represents a crystallization ratio in the recording layer after initialization.

Patent document 2: a phase change optical recording medium including a seed layer which is formed of a mixture film in which metal particles are dispersed in a dielectric material. The seed layer can control particle sizes of the crystal in the recording layer.

Patent document 3: a phase change optical recording medium in which the average particle size of the crystal in the recording layer after initialization is not greater than double the average particle size of crystal in the recording layer after at least 100-time overwriting. Initialization is performed by irradiating a disc in rotation with a laser beam which is relatively wide in the direction perpendicular to the disc rotation direction compared with the disc rotation

direction and which has at least two peak power levels in the disc rotation direction.

Patent document 4: an initialization method including the steps of alternately applying a light beam having a power level for fusing the recording layer and a light beam having a power level for crystallizing the recording layer, and finally applying a laser beam having a power level for crystallizing the recording layer in the end, wherein the crystalline state immediately after initialization is the same as the crystalline state after recording and erasing data several tens of times.

Patent document 5: a phase change optical recording medium wherein the maximum width of the crystalline particle in the recording layer after initialization is from 50 to 500 nm.

Patent document 6: a phase change optical recording medium in which a ratio Z is from 0.50 to 0.85, wherein Z represents a crystallization ratio in the recording layer after initialization.

Patent document 7: a phase change optical recording medium wherein an amorphous state achieved immediately after sputtering has a short range order and the number particle size distribution curve of the crystal after crystallization has multiple maxima.

Patent document 8: a method for initializing a phase change optical recording medium wherein the maximum width of the crystalline particle in the recording layer after initialization is from 0.01 to 0.1 μm.

[0008]

Patent document 9: an initialization method including the step of fusing at least part of a recording layer at once by irradiating a recording layer with a laser beam for initialization which forms an oval shape beam spot on the surface of the recording layer while the major axis of the beam spot is set to be substantially perpendicular to the direction of the recording track.

Patent document 10: a method of initializing a recording layer after reforming an amorphous state achieved just after the recording layer is formed.

Patent document 11: a method in which recording after initialization is performed by overwriting at least twice.

Patent document 12: an initialization method in which the intensity in the longitudinal direction of an elliptical laser beam is reduced at both ends, to obtain the initialization quality that is uniform in the vertical to the track, and the average intensity of the area up to 10% from both ends of the half value width of the laser beam intensity distribution is made smaller than the average intensity within the half value width.

Patent document 13: an initialization method of irradiating an optical recording medium with a laser beam having a power density of P ($mW/\mu m^2$) for T (μsec), wherein P and T satisfy the relationships of $1.0 \leq P \leq 5.0$ and $1 \leq T \leq 100$, respectively.

Patent document 14: an initialization method of irradiating the recording layer with a light beam at a linear velocity of 7 m/s in such a manner that the laser beam does not focus on the position of the recording layer of an optical recording medium.

[0009]

[Patent document 1] Published unexamined Japanese Patent Application No. 10-55539

[Patent document 2] Published unexamined Japanese Patent Application No. 10-106027

[Patent document 3] Published unexamined Japanese Patent Application No. 10-112065

[Patent document 4] Published unexamined Japanese Patent Application No. 11-144336

[Patent document 5] Published unexamined Japanese Patent Application No. 2000-195111

[Patent document 6] Published unexamined Japanese Patent Application No. 2000-195113

[Patent document 7] Published unexamined Japanese Patent Application No. 2000-343826

[Patent document 8] Published unexamined Japanese Patent

Application No. 2002-133711

[Patent document 9] Published unexamined Japanese Patent Application No. 9-212918

[Patent document 10] Published unexamined Japanese Patent Application No. 10-241211

[Patent document 11] Published unexamined Japanese Patent Application No. 2001-126265

[Patent document 12] Published unexamined Japanese Patent Application No. 2000-195112

[Patent document 13] Published unexamined Japanese Patent Application No. 2000-313170

[Patent document 14] Published unexamined Japanese Patent Application No. 2001-283477

[Disclosure of Invention]

[Problems to be solved]

[0010]

An object of the present invention is to provide an optimal method of effectively initializing a phase change optical recording medium in which information can be recorded over a wide range of linear velocity of from 3.5 to 14 m/s.

[Means for Solving the Problems]

[0011]

The problems mentioned above are solved by 1) to 12) of the invention (hereinafter referred to as 1 to 12 of the present invention):

1) an initialization method characterized by including the step of initializing a phase change optical recording medium with a laser beam with a power density of from 15 to 22 mW/μm^2 at a linear velocity of from 8 to 12 m/s to initialize the phase change optical recording medium. The phase change optical recording medium is formed of a transparent substrate having a guide groove on the surface thereof, a first protective layer which is overlaid on the transparent substrate, a recording layer which is overlaid on the first protective layer, a

second protective layer which is overlaid on the recording layer and a reflective layer which is overlaid on the second protective layer. The recording layer consists essentially of a material which is represented by the following composition formula: $Ag\alpha X\beta Sb\delta Te\varepsilon Ge\gamma$, wherein X is at least one element selected from the group of Ga, In, Tl, Pb, Sn, Bi, Cd, Hg, Mn, Dy, Cu and Au, and α, β, δ, ε, and γ have units of atomic % and satisfy the following relationships: $\alpha + \beta + \delta + \varepsilon + \gamma = 100$, wherein $0 \leq \alpha \leq 2$; $0 \leq \beta \leq 10$; $60 \leq \delta \leq 80$; $0 \leq \varepsilon \leq 30$; $1 \leq \gamma \leq 10$; and $5 \leq \alpha + \beta + \gamma \leq 9$ when at least one of α and β is greater than 0;

2) the initialization method set forth in 1, characterized in that the recording layer has a thickness of from 8 to 20 nm;

3) the initialization method set forth in 1 or 2, characterized in that the phase change optical recording medium further comprises an oxide layer which comprises at least ZrO_2 and which is located in at least one of a position between the recording layer and the first protective layer and a position between the recording layer and the second protective layer;

4) the initialization method set forth in 3, characterized in that the oxide layer comprises ZrO_2 as main component;

5) the initialization set forth in 3 or 4, characterized in that the oxide layer contains a titanium oxide;

6) the initialization method set forth in 5, characterized in that the content of the titanium oxide is not greater than 60 mole % based on a total amount of materials included in the oxide layer;

7) the initialization method set forth in any one of 3 to 6, characterized in that the oxide layer further includes at least one of a rare earth oxide and an oxide of a group IIa element exclusive of Be;

8) the initialization method set forth in 7, characterized in that a content of the at least one of the rare earth oxide and the oxide of a group IIa element exclusive of Be ranges from 1 to 10 mole % based on ZrO_2;

9) the initialization method set forth in any of 3 to 8, characterized in that the oxide layer has a thickness of from 1 to 20 nm;

10) The initialization method set forth in any one of 1 to 9, characterized in that the irradiation is performed while the laser beam forms a spot having an area not greater than 200 μm^2 on a surface of the recording layer, and that a light source of the irradiation laser beam has an output power of from 0.7 to 2.5 W;

11) the initialization method set forth in any one of 1 to 10, characterized in that the linear velocity is in a range within + or - 2 m/s of a crystallization limit speed of the recording layer; and

12) the initialization method set forth in any one of 1 to 11, characterized in that the irradiation is performed while the laser beam forms an oval-shaped spot, wherein the following relationship is satisfied: $d/n \leq pf \leq d(n-1)/n$, wherein pf represents a transfer pitch of the laser beam, d represents a half width diameter of the oval-shaped spot in a longitudinal direction, and n is equal to or less than 5, and wherein there is no portion in the recording layer which is subject to irradiation multiple times.

[0012]

The present invention will be described in detail below.

The crystalline state of a recording layer of a phase change optical recording medium after initialization changes depending on the initialization method. The laser beam used for initialization is different from the laser beam used for erasure in overwriting. Spot size (i.e., beam diameter), output power and transfer pitch are different. Therefore, heat diffusion in an actual optical recording medium caused by initialization is greatly different from that caused by overwriting, and therefore it is impossible to solve the problems mentioned above by simply adjusting the linear velocity.

The inventors of the present invention have studied various initialization conditions so that the reflectivity of the recording layer after initialization becomes substantially equal to that after

overwriting and found that the erase ratio at the initial repetitive recordings can be improved by initializing a specific phase change optical recording medium under specific conditions.

Namely, the phase change optical recording medium for use in the present invention contains at least a transparent substrate, and a first protective layer, a recording layer, a second protective layer and a reflective layer which are overlaid on the transparent substrate. The transparent substrate has a guide groove on the surface thereof. The recording layer reversibly achieves a crystalline state and an amorphous state, and is made of a material represented by the formula mentioned in 1 of the present invention. In addition, when the reflective layer contains Ag and the second protective layer contains S, it is preferable to provide a sulfuration prevention layer between the reflective layer and the second protective layer to prevent deterioration of the reflection layer due to sulfuration of Ag.

[0013]

In order to obtain a phase change recording medium in which information can be recorded and played back upon irradiation of a laser beam over a wide range of linear velocity of from 3.5 to 14 m/s, it is necessary to use a material for the recording layer, which contains Sb and Te as main components, Ge and Ag as essential components, and at least one element selected from the group of Ga, In, Tl, Pb, Sn, Bi, Cd, Hg, Mn, Dy, Cu and Au is added. It is already confirmed that this recording layer material can be used for recording over a wide range of linear velocity and that it is easy to resolve the problem of difference in the reflectivity between the crystalline states after initialization and after overwriting by using the initialization methods illustrated in 1 or 10 to 12 of the present invention.

The optimal composition ratio of the elements will be described below.

Sb-Te alloys of a composition ratio around $Sb_{70}Te_{30}$ are phase change recording materials which rarely cause segregation and which have excellent repetitive recording characteristics. It is possible

to adjust the crystallization limit speed by changing the ratio of Sb and Te. When the ratio of Sb is increased, the crystallization limit speed is increased and thereby data transfer speed can be high. The optimal ratio of Sb is from 60 to 80 atomic % to prepare the target phase change optical recording media of the present invention.

[0014]

In the material $Ag\alpha X\beta Sb\delta Te\varepsilon Ge\gamma$ mentioned above for use in the present invention, Sb and Te are included in large amounts.

Therefore, Sb and Te can be considered as mother materials, and Ag, X and Ge, which serve as additive elements. Having focused attention on the total amount of the added elements, the inventors of the present invention have studied the relationship between the total amount of the additive elements and the characteristics of the disc and found that it is preferable to satisfy the relationship: $5 \leq \alpha + \beta + \gamma \leq 9$. That is, when the total amount of Ag, X and Ge (hereinafter referred to as the total addition amount) is too large, disc characteristics of the disc, especially after initial repetitive recordings, are poor. To the contrary, when the total addition amount is too small, preservation reliability of the disc deteriorates. The reasons therefor are considered to be that when the total addition amount is too large, the influence of the elements on Sb-Te becomes also large, and thereby the phase change phenomena can be adversely affected. When the total addition amount is too small, the characteristics of Sb-Te are dominant and preservation reliability of the disc deteriorates, which is a problem specific to Sb-Te.

[0015]

Ge is an essential additive element because addition of a small amount of Ge can greatly improve preservation reliability of a phase change optical recording medium without raising the crystallization point of a material as much as Ga.

Addition of a small amount of Ga can improve crystallization limit speed and raise the crystallization point of the recording layer material to an extent such that an optical recording material

containing Ga can have an excellent mark stability. However, addition of too large an amount of Ga excessively raises the crystallization point of a recording layer and thereby a crystalline state which has a uniform and high reflectivity cannot be achieved upon initialization.

Therefore, it is preferred that the ratio of Ga is not greater than 10 atomic %.

The element In has the same effect as Ga but does not raise the crystallization point as much as Ga. Therefore, to avoid the problems occurring upon initialization, it is useful to use In as a supplementary element to Ga.

Furthermore, other than Ga and In, Tl, Pb, Sn, Bi, Cd and Hg are also effective in improving the crystallization limit speed.

[0016]

It is unknown why addition of these elements accelerates the crystallization limit speed. However, the reason is considered to be that the crystallization of an Sb-Te alloyed metal is promoted. Therefore, Ga, In and Bi are relatively preferable because of their having the same valence as Sb. In addition, Sn is also preferable because Sn has an atomic number relatively near to that of Sb compared with the others and has a high affinity for Sb.

However, addition of too large an amount of these elements deteriorates the reflectivity of playback light and jitters immediately after initialization. Therefore it is necessary to limit the ratio of these elements of Ga, In, Tl, Pb, Sn, Bi, Cd and Hg to not greater than 10 atomic %.

In addition, the inventors of the present invention have made various studies on the additive elements and found that Mn and Dy have the same effect as In. Especially Mn can improve the crystallization speed and in addition has such an excellent preservation reliability effect that the addition amount of Ge can be reduced.

It is also preferable that Cu and/or Ag be included with the additive elements mentioned above. The elements Cu and Ag are

effective in improving reliability. Therefore, by making a good combination of Cu, Ag and the additive elements mentioned above, a desired optical recording medium suitable for recording over a wide range of linear velocity can be obtained and further a recording material which does not cause the problem of differences in reflectivity between the crystalline state after initialization and the crystalline state after overwriting can be designed.

[0017]

It is preferable that the recording layer have a thickness of from 8 to 20 nm. When the recording layer has a thickness less than 8 nm, recording characteristics significantly deteriorate by repetitive overwriting. When the recording layer has a thickness greater than 20 nm, it is difficult to initialize the recording layer uniformly. In addition, the light transmittance thereof becomes insufficient and therefore the reflectivity thereof is low, resulting in decrease of modulation depth level. The preferred thickness of the recording layer is from 10 to 17 nm and more preferably from 10 to 12 nm.

The amorphous state (as-depo state) of the recording layer immediately after the layer is formed varies depending on layer forming conditions. In as-depo state, atoms are relatively disorderly aligned on the substrate. The higher this disorder level, the longer the initialization time.

In this case, it is difficult for the recording layer medium to achieve a desired crystalline state. However, when sputtering is performed at low gas pressure upon application of high voltage, sputter particles flying over to the substrate are thought to have a relatively large kinetic energy compared with that in sputtering under a typical condition. Therefore, an oriented film with certain alignment can be formed and thereby the recording layer can achieve a desired crystalline state after initialization.
Therefore, it is preferable to adopt a low gas pressure and high voltage sputtering method for forming the recording layer.

[0018]

Furthermore, it is found that, when an oxide layer including ZrO_2 as an essential element is provided adjacent to the recording layer (i.e., between the recording layer and the first protective layer and/or between the recording layer and the second protective layer), the phase change optical recording medium in which information can be recorded over a wide range of linear velocities of from 3.5 m/s to 14 m/s can be prevented from causing the bad initialization problem.

The reason therefor is considered to be that because an oxide layer including ZrO_2 has a relatively low thermal conductivity compared with a conventional protective layer including $ZnS-SiO_2$ and therefore the recording layer can absorb initialization energy efficiently, which results in resolution of the bad initialization problem due to shortage of energy. This effect is enhanced as the content ratio of ZrO_2 included in the oxide layer increases.

When an oxide layer contains ZrO_2 as a main component as mentioned in 4 of the present invention, this effect is further enhanced. The reason therefor is that characteristics of ZrO_2 are greatly reflected in the oxide layer. "Main component" mentioned in 4 of the present invention means that ZrO_2 occupies the first place in the ratio of the materials contained in the oxide layer.

This effect can be produced when an oxide layer with a thickness of, for example, 1 nm, is provided. The bad initialization problem can be resolved by raising ZrO_2 ratio in an oxide layer or by thickening the thickness thereof. However, when the oxide layer is too thick, preservation reliability deteriorates. Therefore, the thickness of the oxide layer is limited to from about 1 to about 20 nm and preferably from 2 to 6 nm to avoid the deterioration of preservation reliability.

[0019]

In addition, it is preferred that the oxide layer including ZrO_2 as a main component also include a titanium oxide and a rare earth oxide or an oxide of a group IIa element exclusive of Be.

Addition of a titanium oxide lowers thermal conductivity of the

oxide layer. In addition, titanium oxides are effective in adjusting optical characteristics of the oxide layer and in reducing deterioration of preservation reliability. Rare earth oxides or oxides of a group IIa element exclusive of Be have an effect of reducing volume variance of ZrO_2 due to temperature changes, and thereby stability of the oxide layer against temperature fluctuation upon initialization and recording can be improved.

To obtain these effects, the content of a titanium oxide is preferably limited to not greater than 60 mole % based on the total content of the materials included in an oxide layer and the content of rare earth oxides or oxides of a group IIa element exclusive of Be is preferably from 1 to 10 mole % against the content of ZrO_2.

The content of a titanium oxide is not necessarily limited to this range. However, when the content of a titanium oxide is greater than 60 mole%, whether the resultant oxide layer including ZrO_2 is effective or not is unclear. Therefore, it is preferable to keep the content of a titanium oxide within the range mentioned above.

Specific examples of such rare earth oxides or oxides of a group IIa element exclusive of Be include oxides of Y, Mg and Ca. When the oxide layer includes oxides of Y, Mg and Ca as a solid solution with ZrO_2, preservation reliability of the medium significantly deteriorates. Therefore it is preferable to use such oxides in combination with oxides such as TiO_2.

[0020]

When the optical recording medium mentioned above is initialized under the particular initialization conditions such that the light power density is from 15 to 22 mW/μm^2 and the linear velocity of light beam is from 8 to 12 m/s, the problems mentioned above are solved and the thus obtained phase change optical recording media have good characteristics for initial repetitive recordings.

In the present invention, the initialization conditions are characterized in that the light power density is relatively high and the linear velocity of a light beam is relatively fast compared with

those in conventional initialization methods.

The light power density for the initialization operation in the present invention is determined considering the following. When a recording layer material having a fast crystallization limit speed is used for recording at a high linear velocity, a high irradiation light power is required. This is because initialization tends to become difficult as the crystallization limit speed of the recording layer material increases. In addition, when initialization is performed with a power density in the range of from 15 to 22 mW/μm^2 while the linear velocity and transfer pitch are kept constant, characteristics of the medium in initial repetitive recordings, especially Direct Overwrite 1 (DOW1) characteristics (i.e., recording characteristics for the first overwriting), can be further improved as illustrated in Fig.2.

[0021]

The linear velocity of irradiation light beam for initialization is determined considering the following. While studying the dependence of DOW1 characteristics at a recording linear velocity of 14 m/s on the linear velocity of light beam for initialization with the spot size and the transfer pitch thereof constant, it was found that DOW1 characteristics tend to be improved as the linear velocity of light beam for initialization increases. In addition, the improvement effect is particularly high at the linear velocities of from around 8 to around 12 m/s.

In the case of the light power density being out of the aforementioned range, when the irradiation light power density applied is sufficient for initialization, the heat is accumulated in multiple tracks and thereby the portion subject to initialization achieves an amorphous state. In addition, when the power density used for initializing the disc is excessive, the entire disc is damaged.

As for the linear velocity of an irradiation light beam, when the target recording layer material of the present invention, which has a crystallization limit speed of around 10 m/s, is initialized

at a linear velocity of irradiation light beam greater than 12 m/s (not shown in Fig.3), crystallization of the disc is unsatisfactory, resulting in bad initialization.

[0022]

More preferable conditions are mentioned in 10 to 12 of the present invention.

When a phase change optical recording medium is a disc, the following initialization method is preferably used. Namely, a laser beam which has an oval shape elongated in the radius direction irradiates the disc which is rotated at a constant linear velocity while moving the laser beam in the radius direction with a transfer pitch which is shorter than the spot size (i.e., half width) in the direction of the major axis of the oval-shaped laser beam. Thus, the recording layer is gradually annealed and crystallized.

As a light source for use in initialization, various kinds of sources such as laser diodes and gas lasers can be used. Initialization using a large sized laser diode (LD) is preferable in the light of uniformity of the crystallized layer, disc signal characteristics and productivity. Considering that the current maximum output power of LDs is around 2.5 W, it is preferred that the size (area) of the light source used for initialization be not greater than 200 μm^2 to stably perform initialization at an irradiation light power density regulated in 1 of the present invention.

For example, when the output beam power is set to about 1.3 W using a light source having a spot area of 75 μm^2, the resultant irradiation light has a uniform and stable beam profile.

There is no particular lower limit to the spot size but when the spot size is too small, initialization takes a long time and productivity declines. Therefore, it is preferable to determine the spot size depending on the LD output power.

[0023]

In general, a phase change optical recording medium in which information can be recorded over a wide range of linear velocity of

from 3.5 to 14 m/s tends to cause the problem of difference in reflectivity between the crystalline state after initialization and the crystalline state after overwriting. The problem can be solved by setting the linear velocity of an initialization light beam to a range within + or - 2 m/s of the crystallization limit speed of the target recording layer material.

Furthermore, it is found that a linear velocity in the range from about the crystallization limit speed to the crystallization limit speed + about 1 m/s is particularly effective to alleviate the reflectivity difference problem. When initialization is performed using the linear velocity of an initialization laser beam which is greater than 2 m/s faster than the crystallization limit speed of a recording material, crystallization is not satisfactory. When initialization is performed using the linear velocity of an initialization laser beam which is less than -2 m/s faster than the crystallization limit speed of a recording material, initialization requires an impractically long time. In addition, in this case, it is also confirmed that the reflectivity difference problem is difficult to solve.

[0024]

The entire surface of the optical disc is initialized by moving an initialization light beam pitch by pitch. Specifically, an oval-shaped irradiation light beam scans the optical disc which rotates, while the minor axis of the oval-shaped beam is set to be parallel to the circumference direction of the disc. When the optical disc is rotated by 1 turn, the light beam moves in the direction of the major axis thereof, i.e., radius direction of the disc.

The moving distance (transfer pitch) in the radius direction per rotation needs to be shorter than the major axis diameter of the beam spot in order to avoid non-uniform initialization.

However, it is found that it is preferable for the disc not to be overlappingly initialized in the radius direction, to prevent decrease of productivity, and non-uniform initialization in the radius

direction of the disc, which is caused by uneven application of light energy. In addition, DOW1 characteristics at a recording linear velocity of 14 m/s are also found to ameliorate.

Fig.4 illustrates dependence of DOW1 characteristics on transfer pitch of initialization light beam when recording is performed at a recording linear velocity of 14 m/s while changing the power density of initialization light beam. In this case, the linear velocity of initialization light beam is kept constant and the spot size (i.e., half width) is 1 μm in the direction of the minor axis of the oval light spot. It is found that, in each power density or spot size, DOW1 characteristics tend to ameliorate as the transfer pitch increases.

[0025]

In order to perform initialization such that irradiation is performed without overlapping in the radius direction, the transfer pitch of the initialization light beam and the major axis diameter thereof are equalized. However, an actual irradiation light beam has a beam profile such that irradiation light power density at the beam edge is not sufficient. Therefore, reflectivity of the disc after initialization may vary (non-uniform initialization) in the radius direction. Therefore, it is preferable to set the transfer pitch of the initialization light beam having an oval shape to from 1/n to (n-1)/n, (n is an integer) of the laser spot size (i.e., half width) in the direction of the major axis of the oval light beam.

When irradiation is performed while overlapping (n is not 1), it is found from Fig.4 that DOW1 characteristics are improved as the transfer pitch increases. Therefore, it is preferred that n be less than about 6.

The transfer pitch is determined based on "1/n of the length of the major axis of a beam, wherein n is an integer", but is not necessarily to be exactly 1/n. A variation of from about − 5% to + about 5% is permitted in the present invention.

It is also preferred that a medium having a different shape from

a disc be not overlappingly irradiated too many times. When an optical medium is not a disc-shape, appropriate measures need to be taken according to the shape thereof.

[0026]

Embodiments of the present invention will be described referring to the accompanying drawings.

Figs.5 to 7 illustrate structures of embodiments of the phase change optical recording medium for use in the present invention. In these embodiments, a first protective layer, a phase change recording layer, a second protective layer, a sulfuration protection layer and a reflective layer are overlaid on a substrate. Also, an oxide layer including ZrO_2 as an essential component is provided on one or both surfaces of the recording layer and a second substrate is bonded to the reflective layer with a resin protective layer therebetween.

The essence of the present invention is to improve the erase ratio after initial repetitive recordings of the specific phase change recording medium which satisfies the requirements mentioned in 1 to 9 of the present invention and which is initialized under specific conditions.

Therefore, the present invention is also applicable to any phase change optical recording media which satisfy the requirements mentioned in 1 to 9 of the present invention. Specific examples of the media include phase change optical recording media such as a phase change optical disc of surface recording type, layers of which are formed in a reversed order, and a phase change optical disc, for example, DVDs, in which an optical recording medium is replaced with a substrate for bonding and bonded to the same or a different media with a resin protective layer therebetween.

[Effects of the Invention]

[0027]

According to the present invention, an optimal initialization method is provided for a phase change optical recording medium in which information can be recorded at a recording linear velocity in a wide

range of from 3.5 m/s to 14 m/s.

[Examples]

[0028]

Next the present invention will be specifically described by examples and comparative examples which are provided herein for the purpose of illustration only and are not intended to be limiting.

Each phase change optical recording medium (optical disc) illustrated in the examples and comparative examples are formed as follows:

(1) a first protective layer is overlaid on a first substrate having a diameter of 12 cm and a thickness of 0.6 mm and a track pitch of 0.74 μm thereon, a recording layer is overlaid on the first protective layer, a second protective layer is overlaid on the recording layer and a sulfuration protection layer is overlaid on the second protective layer and the reflective layer is overlaid on the sulfuration protection layer by a sputtering method;

(2) a resin protective layer is formed on the reflective layer by a spin coating method; and

(3) a second substrate made of polycarbonate having a diameter of 12 cm and a thickness of 0.6 mm, which is similar to the first substrate, is bonded to the resin protective layer.

However, an oxide layer mentioned in 3 to 9 of the present invention can be optionally provided and a process of forming the oxide layer is inserted before and/or after the process of forming the recording layer.

[0029]

Example 1

An optical disc was manufactured by overlaying each layer on a polycarbonate substrate in the following order using a sputtering method:

a first protective layer which is made of ZnS (80 mole %)-SiO_2 (20 mole %) and has a thickness of 55 nm;

an oxide layer which is made of ZrO_2 (80 mole %) including

Y_2O_3 (8 mole %) - TiO_2 (20 mole %) and has a thickness of 3 nm;

a recording layer which is made of $Ag_1In_4Sb_{71}Te_{21}Ge_3$ and has a thickness of 11 nm;

a second protective layer which is made of ZnS (80 mole %) - SiO_2 (20 mole %) and has a thickness of 11 nm;

a sulfuration protection layer which is made of Si and has a thickness of 4 nm; and

a reflective layer which is made of Ag and has a thickness of 140 nm.

The thus manufactured medium was initialized under the conditions described in the row of Example 1 in Table 1.

After initialization, reflectivity of the medium was measured using an optical disc evaluation device (DDU-1000, which was manufactured by Pulstec Industrial Co., Ltd.) having a pickup emitting light with a wavelength of 660 nm and including a lens with NA of 0.65, to estimate the distribution of reflectivity in the circumferential direction and in the entire surface of the disc.

In addition, after measuring the reflectivity, random signals were repeatedly recorded twice using an EFM+ modulation method under the conditions such that the recording linear velocity was 14.0 m/s and the linear density was 0.267 μm/bit. Then recording characteristics (i.e., jitters (DOW1 characteristics)) were evaluated at a playback linear velocity of 3.5 m/s and with a playback power of 0.7 mW. The jitter is a value obtained by normalizing data to clock jitter σ using a detection window width of Tw.

In order to evaluate the preservation reliability of each disc, the recording characteristics were measured again after the disc had been preserved in a constant temperature chamber at 80 °C and 85% RH for 300 hours.

The evaluation results are shown in Table 2. The evaluation criteria are as follows.

The reflectivity distribution in the circumferential direction was evaluated based on reflectivity variance in the same circumference

and the criteria are "uniform", "slightly non-uniform" and "non-uniform" when the variance is less than 1%, from 1% to 2% and greater than 2%, respectively.

The reflectivity distribution in the entire surface was evaluated based on variance to the average reflectivity of each circumference and the criteria are "uniform", "slightly non-uniform" and "non-uniform" when the variance is less than 1%, from 1% to 2% and greater than 2%, respectively.

With regard to the DOW1 characteristics, the criteria thereof are E for excellent, F for fair, and B for bad when the jitter is not greater than 9%, greater than 9% but not greater than 10%, and greater than 10%, respectively.

Preservation reliability was evaluated based on jitter variance after the medium had been preserved in a constant temperature chamber at 80 °C and 85% RH for 300 hours. The criteria thereof are E for excellent, F for fair, and B for bad when the jitter variance is not greater than 0.5%, greater than 0.5% but not greater than 1.0%, and greater than 1.0%, respectively. Comparative Examples 1 to 4 are not evaluated for preservation reliability.

The medium manufactured in Example 1 showed excellent results for the reflectivity distributions in the circumferential direction and in the entire surface of the disc, and the DOW 1 characteristics at a recording linear velocity of 14 m/s. In addition, the characteristics of the medium did not deteriorate after preserving the medium in a constant temperature chamber, namely the medium had an excellent preservation reliability.

[0030]

Example 2

The medium manufactured in Example 1 was initialized under the same conditions as illustrated in Example 1 except that the power density of initialization light was 16.0 mW/μm^2 and the linear velocity of initialization light beam was 9 m/s and estimated.

The results of the disc of Example 2 are shown in Table 2. The

medium of Example 2 showed excellent results for reflectivity distributions in the circumferential direction and in the entire surface of the disc, DOW 1 characteristics at a recording linear velocity of 14 m/s and preservation reliability as good as the medium of Example 1.

[0031]

Example 3

The medium manufactured in Example 1 was initialized under the same conditions as illustrated in Example 2 except that the power density of initialization light was 15.3 mW/μm^2 and the transfer pitch of initialization light beam was 18 μm/r and estimated.

The results are shown in Table 2. The medium of Example 3 showed excellent results for reflectivity distributions in the circumferential direction and in the entire surface of the disc, DOW 1 characteristics at a recording linear velocity of 14 m/s and preservation reliability as good as in the media of Examples 1 and 2.

[0032]

Example 4

The medium manufactured in Example 1 was initialized under the conditions described in the column of Example 4 in Table 1.

The results are shown in Table 2. The medium of Example 4 showed excellent results for reflectivity distributions in the circumferential direction and in the entire surface of the disc and DOW 1 characteristics at a recording linear velocity of 14 m/s and preservation reliability as good as the medium of Examples 1 to 3.

[0033]

Example 5

The optical disc of Example 5 was manufactured in the same manner as illustrated in Example 1 except that the recording material was changed to $Ag_1In_3Sb_{72}Te_{20}Ge_4$. The medium was initialized under the same conditions as illustrated in Example 1 and evaluated.

The results are shown in Table 2. The medium of Example 5 showed

excellent results for reflectivity distributions in the circumferential direction and in the entire surface of the disc, DOW 1 characteristics at a recording linear velocity of 14 m/s and preservation reliability as good as the media of Examples 1 to 4.

[0034]

Example 6

The optical disc of Example 6 was manufactured in the same manner as illustrated in Example 1 except that the recording materials used were $Ag_1In_3Sb_{70}Te_{21}Ge_5$. The medium was initialized under the same conditions as illustrated in Example 1 and evaluated.

The results are shown in Table 2. The medium for use in Example 6 showed excellent results for reflectivity distributions in the circumferential direction and in the entire surface of the disc, DOW 1 characteristics at a recording linear velocity of 14 m/s and preservation reliability as good as in Examples 1 to 5.

[0035]

Example 7

The optical disc of Example 7 was manufactured in the same manner as illustrated in Example 1 except that the recording layer had a thickness of 18 nm. The medium was initialized under the same conditions as illustrated in Example 1 and evaluated.

The results are shown in Table 2. Although the reflectivity distributions in the circumferential direction and in the entire surface of the disc were slightly non-uniform and DOW1 characteristics (jitter) surpassed 9%, the characteristics of the disc were not bad on the whole.

[0036]

Example 8

The optical disc of Example 8 was manufactured in the same manner as illustrated in Example 1 except that the oxide layer including ZrO_2 as a main component was not provided. The medium was initialized under the same conditions as illustrated in Example 1 and evaluated.

The results are shown in Table 2. The DOW 1 characteristics

at a recording linear velocity of 14 m/s and preservation reliability thereof were excellent but the reflectivity distributions in the circumferential direction and in the entire surface of the disc were slightly non-uniform.

[0037]

Example 9

The optical disc of Example 9 was manufactured in the same manner as illustrated in Example 1 except that the oxide layer including ZrO_2 as a main component had a thickness of 20 nm. The medium was initialized under the same conditions as illustrated in Example 1 and evaluated.

The results are shown in Table 2. The reflectivity distributions in the circumferential direction and in the entire surface of the disc were excellent but the DOW 1 characteristics at a recording linear velocity of 14 m/s and preservation reliability thereof deteriorated.

[0038]

Example 10

The optical disc of Example 10 was manufactured in the same manner as illustrated in Example 1 except that the oxide layer including ZrO_2 as a main component had a thickness of 8 nm. The medium was initialized under the same conditions as illustrated in Example 1 and evaluated.

The results are shown in Table 2. The reflectivity distributions in in the circumferential direction and in the entire surface of the disc and DOW 1 characteristics at a recording linear velocity of 14 m/s were excellent but preservation reliability thereof deteriorated.

[0039]

Comparative Example 1

The medium manufactured in Example 1 was initialized in the same manner as illustrated in Example 1 except that the linear velocity of irradiation light beam was 6 m/s, and was evaluated.

The results are shown in Table 2. The reflectivity distributions in the circumferential direction and in the entire surface of the disc were uniform but the DOW 1 characteristics at a recording linear velocity of 14 m/s were not satisfactory.

[0040]

Comparative Example 2

The medium manufactured in Example 1 was initialized in the same manner as illustrated in Example 1 except that the linear velocity of irradiation light beam was 14 m/s, and was evaluated.

The results are shown in Table 2. The reflectivity distributions in the circumferential direction and in the entire surface of the disc were non-uniform, i.e., the reflectivity fluctuated, and in addition the DOW 1 characteristics at a recording linear velocity of 14 m/s were also not satisfactory.

[0041]

Comparative Example 3

The medium manufactured in Example 1 was initialized under the conditions of Comparative Example 3 shown in Table 1 and evaluated.

The results are shown in Table 2. The reflectivity distributions in the circumferential direction and in the entire surface of the disc were non-uniform, i.e., the reflectivity fluctuated, and in addition the DOW1 characteristics at a recording linear velocity of 14 m/s were not also satisfactory.

[0042]

Comparative Example 4

The medium manufactured in Example 1 was initialized under the conditions of Comparative Example 4 shown in Table 1 and evaluated.

The results are shown in Table 2. The reflectivity distributions in the circumferential direction and in the entire surface of the disc were non-uniform, i.e., the reflectivity fluctuated, and in addition the DOW 1 characteristics at a recording linear velocity of 14 m/s were also not satisfactory.

[0043]

Table 1

	Power density of initialization light (mW/μm^2)	Output Power of light source (mW)	Area of light beam spot (μm^2)	Linear velocity of initialization light beam	Transfer pitch of initialization light beam (μm/r)
Example 1	17.3	1300	75	11.0	37
Example 2	16.0	1200	75	9.0	37
Example 3	15.3	1150	75	9.0	18
Example 4	17.5	840	48	11.0	15
Example 5	17.3	1300	75	11.0	37
Example 6	17.3	1300	75	11.0	37
Example 7	17.3	1300	75	11.0	37
Example 8	17.3	1300	75	11.0	37
Example 9	17.3	1300	75	11.0	37
Example 10	17.3	1300	75	11.0	37
Comparative Example 1	17.3	1300	75	6.0	37
Comparative Example 2	17.3	1300	75	14.0	37
Comparative Example 3	10.7	800	75	60.0	37
Comparative Example 4	9.0	900	100	6.0	37

[0044]

Table 2

	Reflectivity distribution in circumferential direction	Reflectivity distribution in entire surface	DOW 1 characteristics at a recording linear velocity of 14 m/s (E: excellent; F: fair; and B: bad)	Preservation reliability
Example 1	Uniform	Uniform	E	E
Example 2	Uniform	Uniform	E	E
Example 3	Uniform	Uniform	E	E
Example 4	Uniform	Uniform	E	E

Example 5	Uniform	Uniform	E	E
Example 6	Uniform	Uniform	E	E
Example 7	Slightly non-uniform	Slightly non-uniform	F	E
Example 8	Uniform	Uniform	E	F
Example 9	Uniform	Uniform	F	B
Example 10	Slightly non-uniform	Slightly non-uniform	E	E
Comparative Example 1	Uniform	Uniform	B	-
Comparative Example 2	Non-uniform	Non-uniform	B	-
Comparative Example 3	Non-uniform	Non-uniform	B	-
Comparative Example 4	Non-uniform	Non-uniform	B	-

[Brief Description of the Drawings]

[0045]

[Fig.1] Fig.1 illustrates a diagram for explaining crystallization limit speed.

[Fig.2] Fig.2 illustrates dependency of DOW1 characteristics on power density of irradiation light when the disc manufactured in Example 1 is initialized at a constant linear velocity and transfer pitch followed by recording in the optical disc at a linear velocity of 14 m/s.

[Fig.3] Fig.3 illustrates dependency of DOW1 characteristics on linear velocity of irradiation light beam when the disc manufactured in Example 1 is initialized at a constant linear velocity with the spot size of the irradiation light beam followed by recording in the optical disc at a linear velocity of 14 m/s.

[Fig. 4] Fig.4 illustrates dependency of DOW1 characteristics on the transfer pitch of irradiation light beam when the discs manufactured in Examples 1 and 5 are initialized at a constant linear velocity of irradiation light beam with each power density of

irradiation light followed by recording in the optical disc at a linear velocity of 14 m/s.

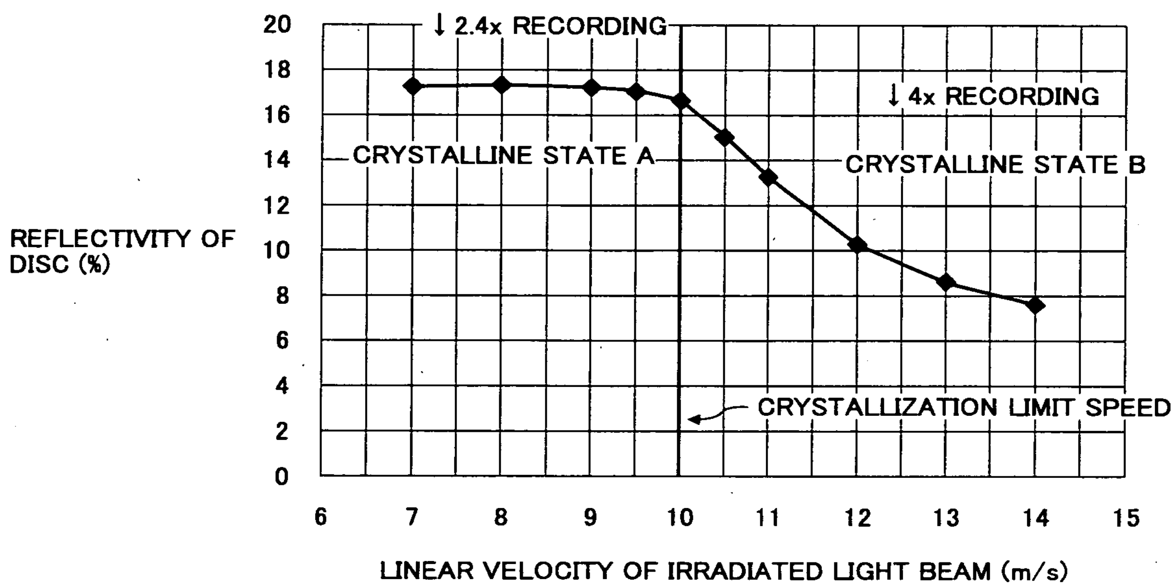
[Fig.5] Fig.5 illustrates a structure of an embodiment of the present invention.

[Fig.6] Fig.6 illustrates another structure of an embodiment of the present invention.

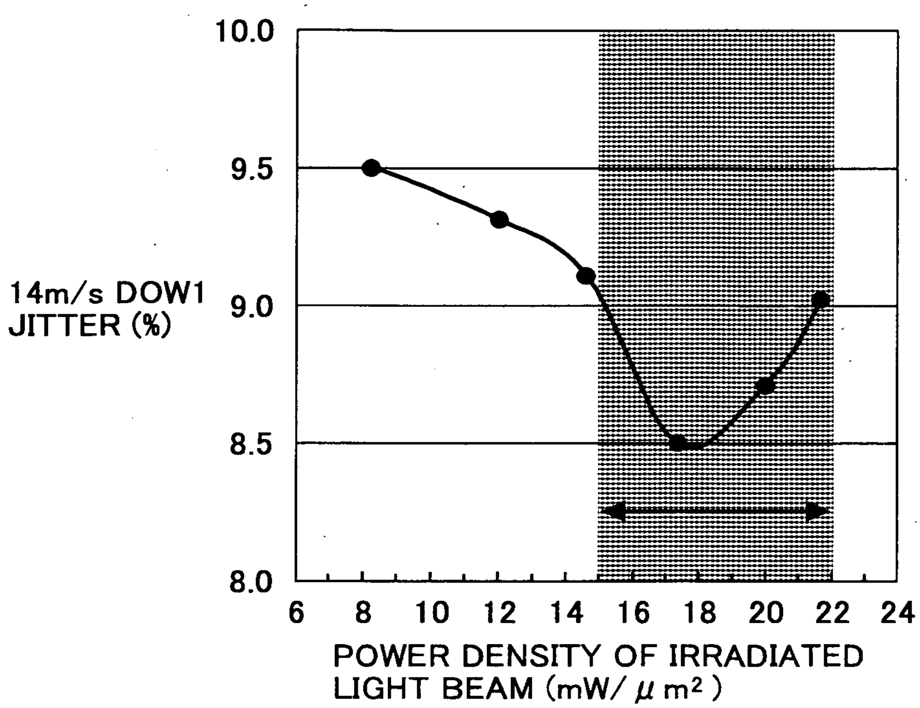
[Fig.7] Fig.7 illustrates yet another structure of an embodiment of the present invention.

[Name of Document]   Drawings

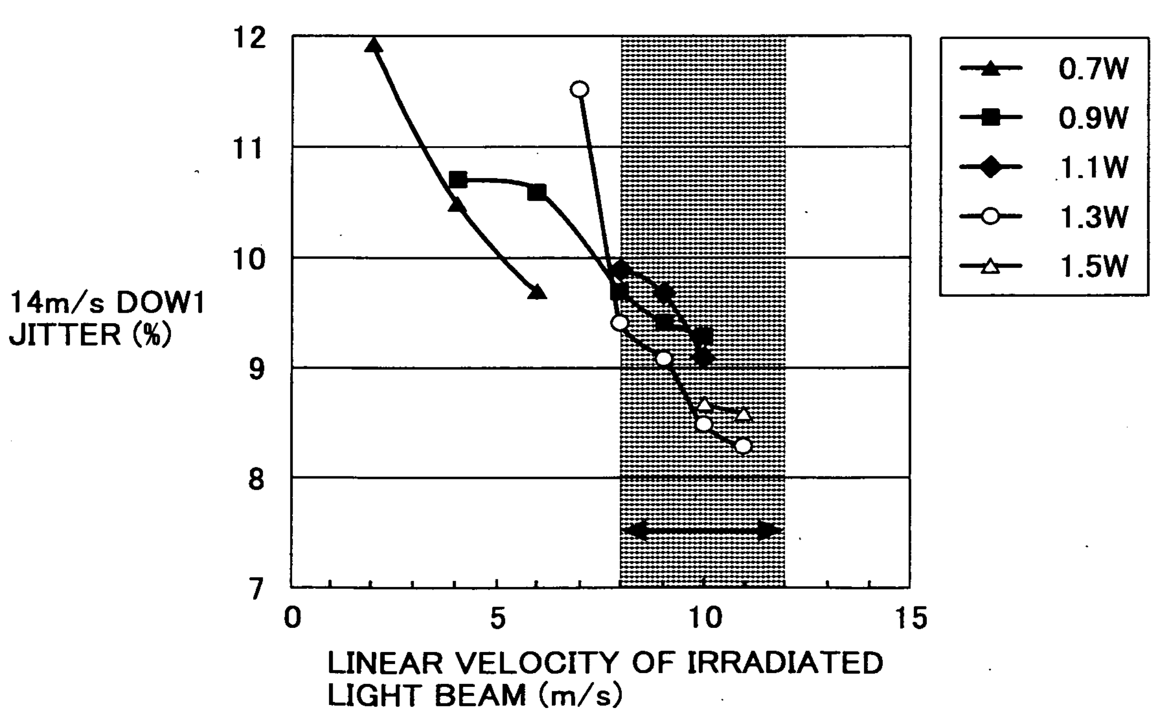
[Fig.1]



[Fig.2]

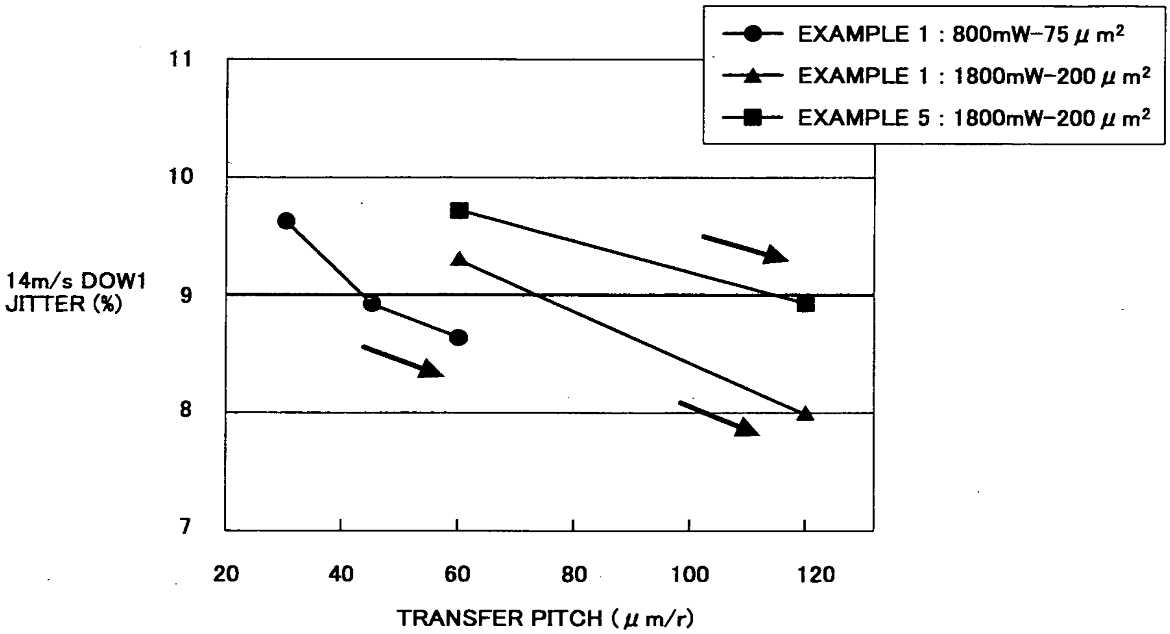

10.0
9.5
9.0
8.5
8.0
14m/s DOW1
JITTER (%)
6 8 10 12 14 16 18 20 22 24
POWER DENSITY OF IRRADIATED
LIGHT BEAM (mW/μm^2)

[Fig.3]

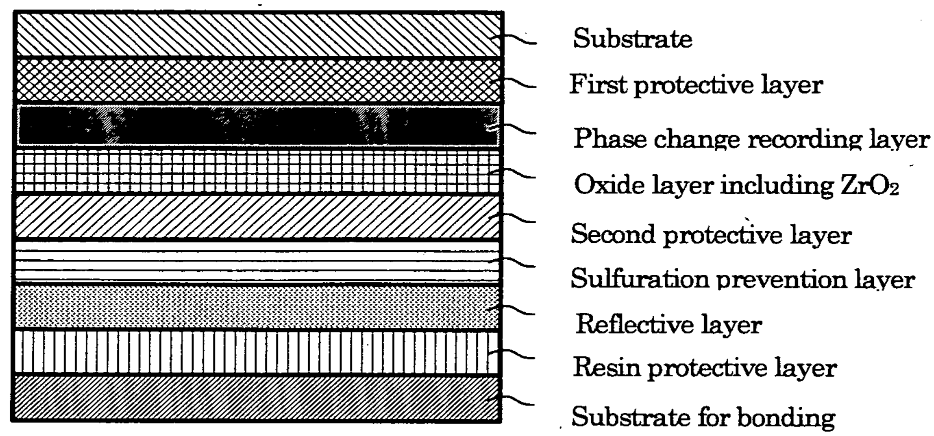

12
11
10
9
8
7
14m/s DOW1
JITTER (%)
0 5 10 15
LINEAR VELOCITY OF IRRADIATED
LIGHT BEAM (m/s)
0.7W
0.9W
1.1W
1.3W
1.5W

]

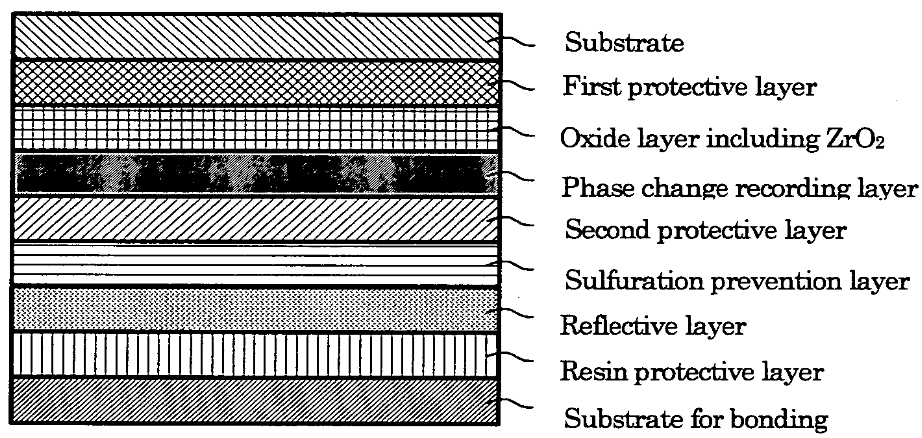
[Fig.4]


EXAMPLE 1 : 800mW-75 μ m²
EXAMPLE 1 : 1800mW-200 μ m²
EXAMPLE 5 : 1800mW-200 μ m²
11
10
9
8
7
14m/s DOW1
JITTER (%)
20
40
60
80
100
120
TRANSFER PITCH (μ m/r)

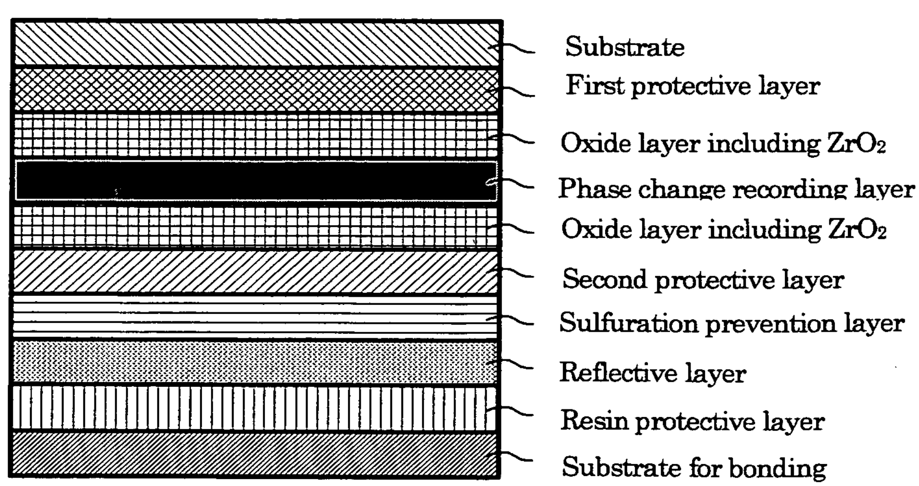
[Fig.5]



[Fig.6]



[Fig.7]



[Name of Document] Abstract of the Disclosure

[Abstract]

[Objectives of the Invention] To provide an optimal method of initializing a phase change optical recording medium in which information can be recorded over a wide range of linear velocity of from 3.5 to 14 m/s.

[Means for Achieving the Objectives] An initialization method including the steps of initializing a phase change optical recording medium with a laser beam with a power density of from 15 to 22 $mW/\mu m^2$ at a linear velocity of from 8 to 12 m/s to initialize the phase change optical recording medium, wherein the phase change optical recording medium contains a transparent substrate having a guide groove on the surface thereof, a first protective layer which is overlaid on the transparent substrate, a recording layer which is overlaid on the first protective layer and which essentially consists of a material which is represented by the following composition formula: $Ag_\alpha X_\beta Sb_\delta Te_\varepsilon Ge_\gamma$, wherein X is at least one element selected from the group of Ga, In, Tl, Pb, Sn, Bi, Cd, Hg, Mn, Dy, Cu and Au, and α, β, δ, ε, and γ have units of atomic % and satisfy the following relationships: $\alpha + \beta + \delta + \varepsilon + \gamma = 100$; $0 \le \alpha \le 2$; $0 \le \beta \le 10$; $60 \le \delta \le 80$; $0 \le \varepsilon \le 30$; $1 \le \gamma \le 10$; and $5 \le \alpha + \beta + \gamma \le 9$ when at least one of α and β is greater than 0.

[Selected Figure] Fig.2